Claims Objections 35 USC § 112

6. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the application regards as his invention.

7. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

8. Claim 1 recites the limitation "said analog controller's output" in step c of the claim. There is insufficient antecedent basis for this limitation in the claim.

Agree to Examiners points 6, 7, and 8. Please see Attachment 1 for proposed claim modification. Petitioner requests interface with Examiner to discuss and clarify claims that will meet the requirements of 35 U.S.C. 112.

Claims Objections 35 USC § 101

9. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefore, subject to the conditions and requirements of this title.

Claims 1 and 2 are rejected under U.S.C. 101 because applicant has filed to claim a practical utility that defines a "real world" context of use. Utilities that require further research to identify or reasonably confirm a "real world" context of use are not substantial utilities.

10. Claims 1 and 2 are rejected under 35 U.S.C. 101 because the claimed invention is not supported by either a specific, substantial, and credible asserted utility or a well established utility.

Examiner interprets that the claimed invention does not present any practical utility. Claims 1 and 2 recite the steps of a process for rapidly controlling a process variable to a set point without overshoot using a time domain polynomial feedback controller that is not applied to any practical utility

In reference to the examiner's points 9 and 10, proposed utility is currently in use. Please see copy of a paper presented to and published by *The Instrumentation, Systems, and Automation Society* (Francis, Robert H., "Asymptotic Approach Algorithm " ISA 2001 Technology Update, Volume LVI Part 1,The Instrumentation, Systems and Automation Society, Research Triangle Park NC, 2001, Page 111 to 120). Herein, the examiner will find:

> The first application for the asymptotic approach algorithm was on a fermenter in a brewing process. The fermentation optimizes when the process temperature is held just below the point where the enzymes are killed. However, the heating rate of the vessel does not affect the process. This application has the conflicting goals of rapidly moving the process variable to setpoint without the process variable overshooting the setpoint. The heating of this 6000-gallon fermenter had been controlled by traditional PID algorithm tuned for no overshoot. The Asymptotic Approach algorithm replaced the PID algorithm with the asymptotic approach algorithm configured for a small knee, the exponent, "*p*" term, was set to a relatively high value. The total batch cycle time for the 6000-gallon fermenter was reduced by ten percent when compared to the PID algorithm tuned for no overshoot. This reduction is a direct decrease to the product production cost and a direct increase in profitability.
>
> The asymptotic approach algorithm was also applied to a drum filling station. The drums are filled to approximately 620 pounds at a rate of 200 pounds per minute. This is an application where the process variable must be moved rapidly to the setpoint. Overshoot, while allowed by the customer (the customer receives more product for free), reduces profits and must be avoided. The asymptotic approach algorithm resulted in the drums being filled to the setpoint within the resolution of the scale, which is one pound.

These two examples are on currently operating production processes/machines at a manufacturer in Chicago, IL and are working to improve production by allowing each system to operate with lower tolerances. The fermenter application was first implemented in March of 2000 and the drum filler was implemented first in November 2000. The applicant trusts this reference meets the requirement for "real-world" context of use as well as a practical utility.

Claims Objections 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentablity shall not be negated by the manner in which the invention was made.

12 Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over USPN 4,948,950 to Rae in view of USPN 5,379,210 to Gruij et al.

As per claim 1 wherein a process for rapidly controlling a process variable to a setpoint without overshoot using a time domain polynomial feedback controller comprising the steps of: a. A means for calculating an error signal by comparing a process variable to a

setpoint; b. A means for setting said controller's output to zero if said error signal is negative; c. A means for calculating said analog controller's output using a user tuned time domain polynomial equation in a feedback configuration; d. A means for automatically converting to an integral correction for said setpoint maintenance based on user defined criteria; and e. A user selectable means for improving a bias tuning parameter automatically based on user defined criteria. Whereby said controller moves said process variable to said setpoint more rapidly in applications where overshoot is not allowed requiring less energy or materials necessary to achieve said setpoint.

The Rae reference discloses

(see figure 1 and column 3 lines 30-37, "The control means 22 .. a temperature sensing means 26 for sensing the actual temperature of cooking oil ... ")

(see column 3 lines 42-49, " The control means 22 ... a set point means 30 and is adapted to permit an operator to select the desired set point temperature for the deep fat fryer 20 ...")

(see column 3 lines 53-63, "The control means 22 ... a microprocessor 31 ... programmed with the new formula ... can turn on and off the heating means 23 through the relay means 32 ...")

(see columns 3-4 lines 64-2, "... shutting down the operation of the heat producing means 23 should the actual temperature of the cooking oil 25 exceed a certain high temperature limit...")

(see column 4 lines 11-15, "... a desired rate of change curve ... asymptotic to the selected set point temperature ... prevent adverse overshooting of the selected set point temperature.")

(see column 5 lines 1-22 "... the actual slope is compared with the target slope and if the actual slope is less than the target slope, the heat source 23 is energized (or merely remains energized) and, if the reverse is true, the heat source 23 is turned off ...")

Rae reference does not expressly disclose c. A means for calculating said analog controller's output using a user tuned time domain polynomial equation in a feedback configuration.

Rae discloses a "new formula" as follows: (see column 4 lines 16-24)

> In particular, a target curve of this invention is described by the formula Stb=(Tsp-T)•S where Stb is the target slope below the setpoint temperature or is the target rate of change of the temperature of the output heating effect of the heating means, Tsp is the desired setpoint temperature, T is the actual temperature of the output temperature effect and S is a selected constant that comprises a sensitivity factor.

Rae's "new formula" is different from the current invention as follows:

> The selected constant "S" is a linear multiplication factor resulting in a linear output to error. The current invention relies upon an nth order polynomial to rapidly change the final control element – and resulting process (measured) variable as said variable is approaching setpoint.

As shown in Figure 1, the current invention results in a significantly faster final control element response as the process variable approaches setpoint. By maintaining the final control element in a maximum output position for a longer time, the overall time for the process variable to approach setpoint is significantly reduced.

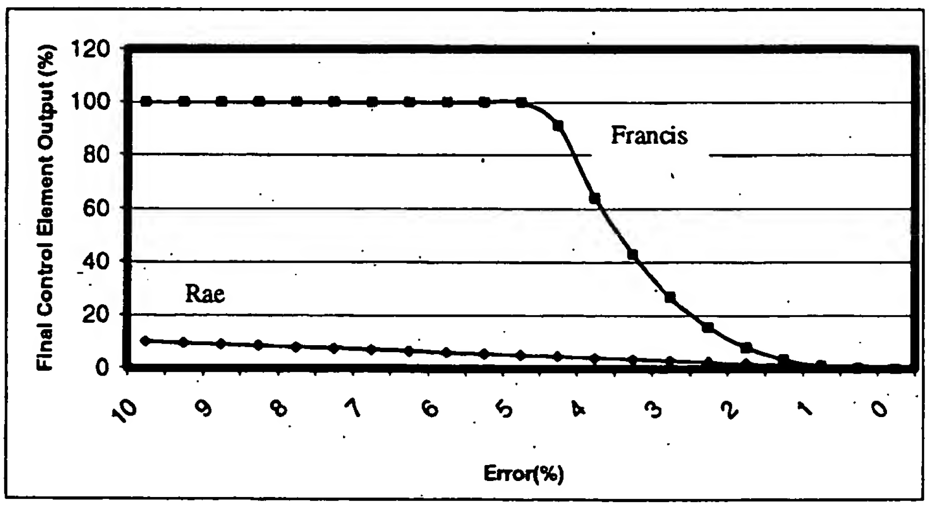

Figure 1: Final Control Element vs Error

The Gruji et al. reference discloses:

(see column 15 lines 66-68, "An input-output form for representing differential equations...")

(see column 16 lines 16-33, "A generalized linear differential equation ...")

(see column 17 lines 6-49, "The transfer matrix function for the input-output description of systems...)

(see column 21 lines 32-34, "The polynomial function is the accurate characteristic polynomial of the closed loop feedback control system.")

While Gruji discusses a polynomial function as applied to control, the discussion is under "2.1 LINEAR INPUT-OUTPUT DIFFERENTIAL EQUATION FORM" (see column 15 line 64). Gruji's reference "The polynomial function is the accurate characteristic polynomial of the closed loop feedback control system" is correctly stated as it relates to linear systems. The primary key to allow for this application is the system demonstrates or may be mathematically approximated as a linear system. Unfortunately most liquid processes are not linear; therefore these techniques require significant analysis and computing power to implement.

Gruji is applying well-understood linear system control theory in development of a state-space matrix for generation of a characteristic polynomial. Gruji does continue to teach the natural tracking controller through state-space variable development and derives a controller that this applicant believes may be applied to non-linear systems, however, the matrix algebra understanding and analysis required to implement the natural tracking controller is significant. These analyses are beyond the typical mathematical realm of a typical process control technician forcing engineers to execute both its implementation and maintenance.

The current invention differs from Gruji as follows:

1. The current invention has been successfully implemented on a non-linear system as a simple polynomial that is easily understood by technicians who have successfully completed a high school algebra course.
2. The current invention is managed/maintained in a similar manner as the PID – the main analog controller in industry.

At the time the invention was made, it would have been obvious to a person of ordinary skill in the art to further define the control means taught by the Rae reference with the natural tracking controller taught by the Gruji et al. reference.

The control system proposed by Rae is applied to a deep fat fryer which, if it were to be modeled mathematically, is a non-linear system. As aforementioned, Gruji's statement: "The polynomial function is the accurate characteristic polynomial of the closed loop feedback control system" is discussed as applicable to a linear system (mathematically). Many college senior texts reference the differences between linear and non-linear systems and that the characteristic control equations developed as control system solutions may not be equally applied between linear and non-linear systems. Therefore, a senior process control practitioner would not attempt to combine the two references and, if he made the attempt, the resulting system would be inoperable.

One of ordinary skill in the art would have been motivated to modify the control means with the natural tracking controller so that the behavior or the output of the control system was optimized with relatively minimal knowledge of the structure of the system being controlled.

While the current invention is very simple and what is simple should be obvious, the aforementioned paper presented to the ISA (the primary international technical society for process control engineering) was co-awarded best paper presented at the ISA Technology Exposition 2001 for best meeting the goals of the ISA. These goals included advancement of process control technology. The invention is intended to reduce the resources that are required to move a process (measured) variable to a setpoint without overshoot; a primary concern of a process control engineer.

The applicant therefore presents, while the simplicity of the invention is one of its main advantages, it has not been obvious to the engineering community primarily focused on process control for the 75 years of ISA's existence.

Attachment 1

$\boxed{\text{Amendment A}}$

Attachment 2